The Chemical Nature of Matter

7-5 The student will demonstrate an understanding of the classifications and properties of matter and the changes that matter undergoes. (Physical Science)

7-5.9 Compare physical properties of matter (including melting or boiling point, density, and color) to the chemical property of reactivity with a certain substance (including the ability to burn or to rust).
Taxonomy level: 2.6-B Understand Conceptual Knowledge

Previous/Future knowledge: Students have been introduced to the concept of properties of matter in 2nd grade (2-4.1), in 3rd grade (3-4.1), and physical properties of the states of matter in 5th grade (5-4.2). Students were introduced to the concept of physical properties but not the chemical properties of matter in previous grades. Students will further develop the concept of physical and chemical properties in high school Physical Science (PS-3.1).

It is essential for students to know that physical and chemical properties can be used to identify substances.

Physical properties can be observed and measured without changing the kind of matter being studied. The following physical properties can be used to help identify a substance:

Melting Point
- The temperature at which a solid can change to a liquid.
- The temperature at which a pure substance melts is unchanging under constant conditions.
- Therefore, the melting point of a pure substance can be used as a physical property for identification. Ice melts to form liquid water at 0^0C (32°F).

Boiling Point
- The temperature at which a liquid boils.
- During the process of boiling a substance changes from a liquid to a gas.
- Boiling begins when the liquid starts to form bubbles throughout, which grow larger, rise to the surface, and burst.
- As long as the substance is boiling the temperature of the liquid remains constant (at the boiling point).
- Boiling point is unchanging under constant conditions for a given substance and therefore can be used as a physical property for identification of the substance.
- The boiling point for pure water at sea level is 100°C or 212°F.

Density
- Density is a property that describes the relationship between the mass of a material and its volume.
- Substances that are denser contain more matter in a given volume.
- The density of a substance will stay the same no matter how large or small the sample of the substance, and therefore, density can be used as a physical property for identification of the substance.
- For example, lead is a very heavy, dense metal. The density of lead is much greater than the density of the very light metal, aluminum.

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NOTE TO TEACHER: Students do not need to calculate density given the mass and volume of a substance.

Color

- Color can be used to help identify a substance, along with other properties.
- By itself color is not a significant identifier of a substance.
- Absence of color is also a physical property.

Chemical properties can also be used to help identify a substance. Chemical properties can be recognized only when substances react or do not react chemically with one another, that is, when they undergo a change in composition. A chemical property of one substance usually involves its ability to react (combine) or not react with another specific substance. Two examples of chemical properties include:

The ability to burn

- The ability of a substance to burn is a chemical property that involves a substance reacting quickly with oxygen to produce light and heat.
- The process is called *burning*.

The ability to rust

- The ability of a substance to rust is a chemical property that involves a substance reacting slowly with oxygen.
- The process is called *rusting*.

It is not essential for students to calculate the density of a substance if given its mass and volume.

Assessment Guidelines:

The objective of this indicator is to *compare* physical properties to chemical properties of matter; therefore, the primary focus of assessment should be to determine the similarities and differences between physical and chemical properties of matter. However, appropriate assessments should also require students to *classify* properties as being physical or chemical; *exemplify* physical and chemical properties used to identify substances; or *summarize* the ways that physical properties and chemical properties are used to identify matter.